

Comparative Method for Studying Costs of Air Pollution

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MANY medical, environmental, and engineering studies have been devoted to air pollution, but little research has been devoted to the determination of costs and economic losses due to air pollution. The first and still the best known of such investigations was conducted in 1913 by the Mellon Institute to determine the economic cost of smoke nuisance in Pittsburgh for six large categories (1).

It is interesting to note that the Mellon Institute investigators arrived at a per capita figure of \$20 annually in 1913, including costs to the "smoke maker" for unburned fuel; to the individual for laundering and drycleaning; to the householder for interior and exterior maintenance and lighting; to store owners for damaged merchandise, cleaning, and lights; and to quasi-public building operators for interior and exterior maintenance and lighting of office buildings, hospitals, and so on. Health effects were not included.

Many cost estimates for individual cities, such as those cited by the Air Pollution Control Association's Committee on Economic Effects in a summary report in March 1963, are surprisingly enough no higher than the \$20 per

capita estimate for Pittsburgh in 1913: New York City \$16, Chicago \$20, Milwaukee \$17, Indianapolis \$14, and various cities (Department of Commerce estimates) \$8 to \$20. The bases of these various estimates, when not attributed to extrapolation from the 1913 Pittsburgh data, are usually unclear.

A 1959 extrapolation from the Pittsburgh data, on the basis that the commodity price index had tripled since 1913, resulted in estimates of \$60 annually per capita and \$210 per family in Pittsburgh (2). It is conceivable that the recent estimates of \$11 billion annually (3) for the entire United States were based on this kind of extrapolation. Applying such an extrapolated per capita figure to the entire country can be disputed, since only about 25 percent of the U.S. population live in cities having major air pollution problems (4). But the incompleteness of the damage effects included in city estimates are used to justify the higher total estimate. (Actually, an additional 34 percent of the population live in urban places with moderate and minor air pollution problems.) For example, the city estimates mentioned did not include the more rapid deterioration of clothing in polluted areas, the more frequent washing of cars, nor the extensive damage to agriculture and health.

It is obvious that estimates of the economic effects of air pollution are vague and uncertain. Such estimates can hardly be convincing to the

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public or to legislators who must approve laws and funds for the establishment and operation of control agencies. It is therefore imperative that guessing be replaced by more firmly established cost figures.

Toward this end, we performed a study in the Upper Ohio River Valley in 1960. Considering the vast scope of the problem, our effort must be viewed as only a pilot study. Although its conceptual framework, design and execution, and the results obtained are presented, we emphasized the methodology to allow persons interested in pursuing such studies to profit by this example.

Study Design

A 1959 study of the quantitative levels of air pollution in nine communities of the Upper Ohio River Valley revealed that very high levels occurred in some of these communities (5). The study also indicated that this valley was a suitable place to attempt a paired comparison study of various costs of air pollution to the communities, and especially to "come to grips" with the question, How much more does it cost a family to live in a polluted atmosphere than it does a comparable family to live in relatively unpolluted air?

Selection of Areas

The basic criterion in selecting communities for cost studies was similarity in every way possible except in the level of air pollution, in which the difference was to be as great as possible. Large differences occur in air pollution levels in the Upper Ohio River Valley. The area is heavily industrialized with a number of major steel and other heavy industry plants. Its air pollution problems are acute and may be among the most severe in the United States. (The city of Donora, Pa., with the worst air pollution episode [1948] in the United States is located in this region.)

By confining the survey populations to between 10,000 and 50,000, we thought it would be possible to obtain an acceptable sample from two communities in this area at relatively low cost. Steubenville, Ohio, and Uniontown, Pa., were selected. Steubenville in 1960 had an estimated 36,400 residents and 9,500 households.

Uniontown had 21,000 residents and 6,400 households.

Comparability of the two selected communities was of critical importance to the study. Detailed information was not readily available in 1960, although much could be learned from economic data in such sources as sales-management publications, local city government offices, and discussions with key persons. The air pollution levels obtained from *Consumer Reports* measurements (5) indicated a wide difference in the amount of suspended particulates between the two cities. Although Uniontown was relatively clean compared with Steubenville, its air was fully as polluted as the average of many much larger cities in the monitoring network of the Public Health Service. Nevertheless, the distinguishing difference between these two cities was in the level of air pollution. Table 1 summarizes the comparative data available at the time of the study.

The two cities differed markedly in a number of factors, some of which could influence reactions to air pollution and therefore would be important considerations in future studies. The most important differences include topography (6) and the occupational distribution of the population.

Steubenville, on the Ohio River, can be divided into three distinct areas:

1. The plain area (adjacent to the Ohio River), where the industrial plants are located.

Table 1. Socioeconomic, climatic, and air pollution data for Steubenville, Ohio, and Uniontown, Pa., 1959

	Steubenville	Uniontown
Population.....	36,400	21,000
Number of households.....	9,500	6,400
Persons per household.....	3.83	3.28
Income:		
Per household, cash.....	\$6,124	\$5,535
Per spending unit.....	\$5,532	\$5,108
Per capita.....	\$2,006	\$1,897
Mean annual temperature, ° F....	56	57
Mean annual precipitation, inches.....	33	45
Air pollution levels, micrograms per cubic meter:		
Minimum.....	119	21
Maximum.....	1,238	193
Average.....	383	115

2. The hillside area adjacent to the plain.
3. The hilltop area above the Ohio River Valley.

Discussion with public health and city officials indicates that the air pollution levels vary considerably from one area to another, primarily because of the different elevations.

Uniontown is situated on a relatively flat plain and has homogeneous topographic characteristics. Discussion with officials of the city disclosed relatively uniform levels of air pollution throughout this area.

The two cities are not nearly as comparable in economic activities and social characteristics as in population and income levels (table 1).

Steubenville has an excellent transportation network by river, rail, and highway. Foremost is the Ohio River, which offers superior, cheap waterway transportation connections.

The availability of good transportation, together with strip and deep coal mines, has created excellent industrial growth potential in

Table 2. Percent distribution of social and employment characteristics in Steubenville and Uniontown, 1960

Characteristics	Steubenville		Uniontown	
	Number	Percent	Number	Percent
Total population.....	32, 495		17, 942	
Native born.....		91. 7		94. 2
Foreign born.....		8. 3		5. 8
Native population.....	29, 800		16, 902	
State of residence.....		69. 4		88. 2
Other State or location.....		30. 6		11. 8
Residents in 1955 ¹	29, 478		16, 427	
Same house in 1960.....		52. 2		55. 0
Other house.....		47. 8		45. 0
Married couples.....	17, 417		3, 982	
With own household.....		96. 7		96. 4
With children under 6 years old.....		25. 9		28. 2
With children under 18 years old.....		53. 2		52. 3
Total employed.....	11, 998		5, 810	
Manufacturing.....		39. 3		15. 3
Primary metal industries.....		33. 5		. 2
Other manufacturing.....		5. 8		15. 1
Transportation.....		3. 4		3. 3
Trade.....		21. 5		13. 5
Services except private houses.....		22. 1		21. 8
Private households.....		2. 5		3. 4
Other.....		13. 7		46. 1

¹ 5 years and older.

the Steubenville area. The city is heavily industrialized, with two major steel plants, a large vanadium metal plant, and numerous firms producing such products as paperboard, paper boxes, hardware, electrical parts, bricks, alloy steel, tin plate, ferro-alloy metals, and numerous other products, manufactured in more than 100 plants.

Uniontown, south of Pittsburgh, has adequate land transportation facilities but does not have access to water transportation. It is not an industrial town and has less than 10 manufacturing firms. It is basically the trading and financial center of the surrounding region as well as the county seat. The detailed statistical comparison in table 2, obtained from the 1960 census (not available at the time of the study) shows other similarities and differences between the two cities.

Differences in the economic activities of the two cities are chiefly responsible for the considerable differences in levels of air pollution, and the differences in occupational distribution of population were an inherent aspect of this study situation.

Selected Categories for Study

The following six categories were selected for study:

1. *Outside maintenance of houses.* We investigated the upkeep requirements of commonly used building materials such as masonry and similar surfaces, painted wood, aluminum, and drainpipes, and the outside cleaning of houses.

2. *Inside maintenance of houses and apartments.* One of our major activities was investigating the efforts necessary to maintain the proper cleanliness of a variety of household items, including walls, windows, window shades, curtains, drapes, venetian blinds, carpets, rugs, and upholstered furniture. In addition, we examined the costs of touching up paint or plaster and painting or redecorating walls.

3. *Laundry and drycleaning.* Outer wearing apparel for men and women and boys and girls were a major consideration. The wearing apparel included men's sport or dress shirts, men's and women's suits, women's white blouses and colored dresses, and children's shirts,

trousers, blouses, and washable skirts. The investigation distinguished between summer and winter maintenance practices since seasonal influences are of special importance in cleaning and laundering decisions.

4. *Women's hair and facial care.* The hair and facial care of women 16 years of age and over were studied; also the incidence of complexion faults and the methods used by the respondents in correcting them.

5. *Inside maintenance of offices.* This category included the cleaning of windows, curtains, and walls, as well as the touching up of paint and plaster.

6. *Store operation and maintenance.* Our investigations in this category dealt with the cleaning of employee uniforms, walls, windows, and outside masonry. The examination included maintenance of business vehicles, painting of wooden surfaces on the outside of stores, and spoilage of merchandise.

In retrospect, most of the categories related to the effect of air pollution on household operations; for example, private home maintenance and laundry. They were well selected and resulted in meaningful data. However, the data for office and store maintenance were discarded, mostly because of the heterogeneity of the establishments. Too, the small number of respondents in these categories made comparisons meaningless.

Methodology

At the outset, we clearly understood that our study data on economic costs attributable to air pollution would represent only a portion of the total costs that might be imposed by air pollution. This was true particularly because each of the types of activity selected for study could not, within the restrictions imposed by study funds, be investigated in complete detail. Other factors would also affect the levels of expenditure.

We sought three types of data in each of the six categories:

Activity frequency. The frequency with which various functions that might be directly influenced by air pollution were performed; for example, the average waiting period before repainting the exterior of frame houses.

Incidence. The proportion of the population to which various frequencies were applicable; for example, the number of families owning homes with wood exterior walls.

Control. Factors that might influence either the frequency of an activity or the number of families that might perform the activity, so that comparison groups could be matched to some degree; for example, household income, educational level, and so on.

Six questionnaires were designed, one for each area of activity. Each questionnaire included 25 to 75 direct or indirect queries. Direct questions were asked to obtain information on incidence and control. However, lest the respondents, many of whom became aware of the study's purpose, exaggerate their responses to questions about frequency of activities, the questions were phrased obliquely. For example, "How long did it take before your outside masonry showed an appreciable change in appearance?" In no instance was the question asked as to how much money had been spent for maintenance of the item. Activity frequency comprised the bulk of questions on a total of 89 activities.

The three questionnaires on household activities were distributed by mail. The other three questionnaires were distributed at group meetings. This was judged advisable because of the specialized nature of the activities. Store operations and office maintenance, for example, are a primary concern of businessmen who regularly attend meetings of the Chamber of Commerce, Rotary Club, and other such organizations, and they could easily be reached in this way.

Sample families for the three mail questionnaires were selected from the telephone directories of the survey cities. For the Steubenville outside-maintenance questionnaire, the samples were selected from a city directory listing private owners by street and dwelling. This information was not available for Uniontown.

The mailed questionnaire dealing with inside maintenance of private homes and apartments was returned by 379 persons or 4 percent of the 9,500 private households in Steubenville, and 164 persons or 3 percent of the 6,400 households in Uniontown (table 3).

The mailed questionnaire dealing with laundry and drycleaning was returned by 246 or 3 percent of the approximately 9,100 adults 21 years old and over in Steubenville, and 149 or 3 percent of the approximately 5,200 adults 21 years old and over in Uniontown.

The sample size for outside maintenance of residential houses was 361 or 6 percent of the approximately 5,700 residential houses in Steubenville, and 204 or 5 percent of the approximately 3,850 residential houses in Uniontown.

The hair and facial care group questionnaire was returned by 3 percent or 347 women 16 years of age or over in Steubenville, and 2 percent or 129 women 16 years of age and over in Uniontown.

The office maintenance group questionnaire was distributed to 50 offices in Steubenville and 50 offices in Uniontown.

The store operations questionnaire was distributed to 80 stores in Steubenville and 50 stores in Uniontown.

Undoubtedly some bias occurred in the three group-distributed questionnaires, since these were not random population samples and the

Table 3. Number and percent of mail and group questionnaires returned, by city and type of questionnaire, 1960

Type of questionnaire	Dis-tributed	Returned and processed	
		Num-ber	Per-cent
<i>Group</i>			
Steubenville:			
Hair and facial care.....	400	347	84
Office maintenance.....	50	34	68
Store operations.....	80	29	36
Uniontown:			
Hair and facial care.....	150	129	80
Office maintenance.....	50	26	52
Store operations.....	50	18	36
<i>Mail</i>			
Steubenville:			
Inside maintenance of homes....	1,000	379	38
Laundry and drycleaning.....	920	246	26
Outside maintenance of homes..	1,000	361	36
Uniontown:			
Inside maintenance of homes....	410	164	40
Laundry and drycleaning.....	410	149	36
Outside maintenance of homes..	710	204	29

respondents were members of the organizations at whose meetings the questionnaires were distributed.

Some bias also occurred in the three mail questionnaires due to the choice of telephone directories as the universe. Low-income households without telephones were not represented.

Unfortunately, the lack of detailed and up-to-date information on education, age, family size, and so on, for the survey cities limited comparison of the communities and the samples to the characteristics listed. Analysis of the demographic and related data from the questionnaires used in both Steubenville and Uniontown showed, however, that the respondent samples for the two survey cities were similar.

Citywide programs were started to raise the rate of response to the questionnaires. Information on progress was reported by local daily and weekly newspapers, and interviews were taped by a well-known local radio commentator for a favorite local radio program. A system of telephone followup calls was used in both survey cities to urge prompt return of the long questionnaires. All followup calls were directed to either husband or wife of the household receiving the questionnaire. The Steubenville Health Department and the Uniontown Chamber of Commerce assisted materially in obtaining citywide cooperation.

Analysis of Data

Since the level of income may influence the frequency of maintenance activities, and therefore the cost, cost comparisons should be made only within each income group, and the total costs of air pollution calculated on the basis of the numbers of families and persons in each income group in each study city.

The questionnaires were tabulated so that maintenance frequency data could be observed among various income groups. Although income data were obtained in steps of \$2,000, only two income categories were used: less than \$8,000 and \$8,000 or more. Further breakdowns left too few respondents in the various groups.

The maintenance frequency factor was then calculated, and the frequency factors converted into dollar values. For this, local market

Table 4. Summary of economic cost of air pollution, home and personal care, Steubenville, Ohio, 1960

Activity	Gross cost differences ¹	
	Annual	Per capita ²
Outside maintenance of houses	\$640, 000	\$17
Inside maintenance of houses and apartments	1, 190, 000	32
Laundry and drycleaning	900, 000	25
Hair and facial care	370, 000	10
Total	3, 100, 000	84

¹ Between Steubenville and Uniontown.

² Based on estimated 1959 population of 36,400.

prices for the various household services were used for each item studied. Although local market prices were obtained from the survey cities, only those from Steubenville needed to be applied to the household activity frequency factors in the development of household costs, because air pollution is not likely to be a major cause of regional differences in prices. We used the local market prices from one survey city only in order to eliminate the effects of differing regional price levels.

The questionnaire classification data and some fieldwork provided average information such as the number of members in a family, the number of rooms in a house, the number and size of curtains in a room, the size of a room, the size of a carpet, and so on. Cost figures were developed for these average conditions on the basis of maintenance price information obtained for such homes.

Steubenville and Uniontown household-activity cost differentials for various items, on both a do-it-yourself basis and a contractual basis, were computed for the low- and high-income groups. (The authors can provide these on request.) As expected, the upper income families in Steubenville spent much more money for cleaning purposes than the lower income families and their counterparts in Uniontown.

Table 4 gives the economic cost of air pollution for Steubenville as a whole, on an average per capita basis, without regard to income levels

and including the cost of labor on a contractual basis. These costs include only the 54 items relating to home and personal care. The indirect costs relating to increased costs of store and office maintenance are not included.

As stated, our findings only roughly indicate the magnitude of the problem and only a portion of the total spectrum of the economic effects of air pollution (7).

While there is little doubt, judging from these findings, that factors such as income had to be reckoned with, greater accuracy might have been obtained by dealing with additional factors such as education and the size of a family. Information concerning some of these factors was available from the questionnaires, but the data could not be used because the number of subsamples was too small and because our time and funds were limited.

Furthermore, our study did not take into account the possibility that the standards of cleanliness might be different in the two communities and between the income groups within the communities. The inhabitants of the "dirtier" city could have accepted lower standards of cleanliness either because they could not afford the extra money or because they had grown accustomed to the lower levels or both. Some of the data confirm this view. Sometimes there was little or no difference in cost between the lower income comparison groups, but a distinct difference between the upper income groups; for example, in washing exterior walls of private homes.

The difference between the practices of the lower income groups was small—only 5 percent higher frequency in Steubenville than in Uniontown—but between the higher income groups there was a large difference. In Steubenville the homes were washed outside about twice as often as in Uniontown (0.9 year versus 1.9 years). Probably the lower income families in downtown Steubenville needed but could not afford to have their houses washed (average cost \$550) twice as often as the lower income group in Uniontown.

Despite the stated deficiencies of this study, it points out that additional effort seems to be warranted in assessing the economic damage brought about by air pollution. Refinements in study techniques are highly desirable, par-

ticularly in the choice of comparable areas, sample families—size of family, composition, education, size and type of home, and family income should be matched carefully—and methods of collecting data to insure closer to 100 percent returns; for example, interviews instead of mail questionnaires. These steps will produce not only more valuable data but will keep the costs of such studies at a minimum.

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Additions to Drug Abuse Control Amendments

Sixteen drugs, in addition to amphetamines and barbiturates, have been brought under the new Drug Abuse Control Amendments. A distinctive symbol, a large C encircling an Rx (prescription drug symbol) set against a contrasting background, has been established to identify these drugs and to aid manufacturers, distributors, pharmacists, and others in complying with the new law. These drugs were covered by the amendments when they became effective last February 1.

Manufacturers, distributors, and pharmacists must keep records on their production, receipt, and distribution for 3 years. Physicians who regularly dispense drugs to patients who are charged either separately or with charges for other professional services are also required to keep such records.

The 16 drugs, by generic name and some trade or other name are:

- Drugs having a potential for abuse and habit formation because of their stimulant effect on the central nervous system: *d*-, *dl*-Methamphetamine and their salts; (*di*-, *dl*-Desoxyephedrine and their salts).

- Drugs having a potential for abuse because of their depressant effect on the central nervous system: chloral hydrate (Chloral), chlordiazepoxide and its salts (Librium), diazepam (Valium), ethchlorvynol (Placidyl), ethinamate (Valmid), glutethimide (Doriden), meprobamate (Apascal, Atraxin, Biobamat.

Calmiren, Cirpon, Cyrpon, Ecuamil, Equamil, Equamil LA, Harmonin, Mepantin, Mepavlon, Meproleaf, Meprosin, Meprospan, Meprotabs, Miltown, Nervonus, Neuramate, Oasil, Pamaco, Panediol, Perequil, Perquietil, Pertranquil, Placidon, Probamyl, Quamil, Quilate, Sedabamate, Sedasil, Urbil, Viobamate), methpyrlyon (Neludar), paraldehyde.

- Drugs having a potential for abuse because of their hallucinatory effect: dimethyltryptamine (DMT), *d*-Lysergic acid diethylamide (LSD-25; LSD), mescaline and its salts, peyote, psilocybin, psilocyn.

Phenmetrazine hydrochloride (Preludin) was 1 of 17 drugs proposed for inclusion under the amendments last January 18, but is not included in the final order. However, the drug is still under study, as are a number of other related compounds.

The order also specifically exempts the non-drug use of peyote in bona fide religious ceremonies of the Native American Church. However, persons supplying peyote to the church are required to register and maintain appropriate records.

Combinations of the 10 stimulant and depressant drugs with other compounds (except amphetamines and barbiturates) are temporarily exempted from the inventory and recordkeeping requirements until August 1, 1966. The six hallucinogenic drugs are legally available only for experimental use.

Program Notes

District of Columbia Uses Isoniazid

The District of Columbia Department of Public Health plans to administer the drug isoniazid in the census tract of the city where tuberculosis is in excess of 300 cases per 100,000 population—more than triple the case rate for the city as a whole. In this tract, the department opened a new center for tuberculosis control in January 1966.

Residents of the tract will be given tuberculin skin tests, and those who react positively will receive chest X-rays. If active tuberculosis is found, hospital and clinical care will be provided.

During 1964, the health department reported a total of 503 new active cases of tuberculosis in the District of Columbia—62.6 per 100,000 persons, which is an increase of 4.5 over the 1963 case rate. The national rate is 26.3 per 100,000.

Labor Joins Attack on Alcoholism

The United Steel Workers of America, AFL-CIO, recently teamed up with the Pennsylvania Department of Health to conduct an institute on alcoholism.

Sessions were scheduled every Monday night from January 10 through February 28, 1966, in McKeesport, in the USW's district 15 in western Pennsylvania. Speakers dealt with these topics: Why We Are Here; Alcoholism Relative to the Job; Development of Alcoholism; Alcoholism and the Family; Treatment; Rehabilitation; and Alcoholism and Community Services. A panel session was concerned with Treatment Facilities—Greater Pittsburgh Area.

Preparing to Certify Hospitals

New York State has held its first orientation session to acquaint health personnel with their new duties of

hospital certification under State and Federal programs. The hospital organization and administration course was given at hospitals in five cities throughout the State in January 1966.

Faculty were from the host hospital, the State health department, and Columbia University's School of Public Health and Administrative Medicine, a co-sponsor.

Personnel of health departments will be involved in certifying hospitals, checking, for example, quality of medical care, rates, and the safety and efficiency of the physical plant. The State health department received responsibility for such certification through 1965 action of the State legislature.

Health Planning in War on Poverty

Action for Boston Community Development, Boston's antipoverty organization, is using health planning in the war on poverty.

According to Paul Mico, supervisor of health planning, priorities have been established for activities designed to produce reliable health data, strengthen and support municipal health services and other important health resources, and meet the needs of well-defined lower-income and underprivileged target populations. The organization seeks to use sound health planning in the provision of comprehensive health services.

The youth health program of the city has a contract with Boston City Hospital to provide physical and dental examinations and medical treatment for school dropouts and unemployed youths, aged 16 to 21, who are recruited into job training and employment activities. A program of comprehensive medical care for medically indigent infants and children is being carried out under

contract to Beth Israel Hospital. Project Head Start is designed to give pediatric, dental, and mental health services to prekindergarten children through the pediatrics departments of five major teaching hospitals. A skid row project, through contract with the Boston University Medical School's psychiatry department, provides a broad array of services to homeless alcoholics and isolated adults. The Bromley Park Family Health Center provides community health services to residents of the public housing development there, a program being carried out in cooperation with the Boston Health Department and the Harvard School of Public Health.

Health Information for Librarians

A new service of the Maryland State Department of Health assists public and school librarians throughout Maryland in providing health information to students and the general public. The library extension division of the Maryland State Department of Education is cooperating with the health department's office of public health education on the project.

The program will include mailings from the health department's public health library to librarians in public and private elementary and secondary schools, colleges, nursing schools, and public libraries. The health department librarian will send appropriate publications of the department and suggest others from various sources, as well as help a librarian locate information on specific health topics. Each librarian will receive bimonthly the health department's official *Bulletin*, which interprets some of the health programs, problems, and advances in Maryland.

Items for this page: Health departments, health agencies, and others are invited to share their program successes with others by contributing items for brief mention on this page. Flag them for "Program Notes" and address as indicated in masthead.
